INDUSTRIAL HYGIENE SECTION

This Industrial Hygiene Section is published to promote sound thought upon and concerning industrial hygiene. To that end it will contain articles, discussions, news items, reports, digests, and other presentations, together with editorial comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited.

Industrial Medicine

Reg. U S. Pat. Off.

The Editorial Committee will exercise its best judgment in selecting for publication the material which presents most exactly the factors affecting industrial health and developments for control of potentially injurious exposures. The editors may not concur in opinions expressed by the authors but will endeavor to assure authenticity of fact.

The Science, the Law and the Economics of Industrial Health

Volume 9 **JANUARY, 1941** **Section 1**

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OFFICIAL PUBLICATION of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, WARREN A. COOK, Chicago, Ill., *President;* DONALD E. CUMMINGS, Denver, Colo., *President-Elect;* GORDON C. HARROLD, Detroit, Mich., *Secretary;* THEODORE HATCH, Philadelphia, Pa., *Treasurer.*

Published in January, April, July, and October of each year as the Industrial Hygiene Section of INDUSTRIAL MEDICINE.

Editorial Offices:

540 North Michigan Ave., Chicago, Illinois.

Managing Editor:

A. D. CLOUD, Managing Editor, INDUSTRIAL MEDICINE.

The Response of Rabbit Skin to Compounds Reported to Have Caused Acneform Dermatitis

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THOSE of us acquainted with the industrial field have recognized the need of an experimental method for studying skin irritation. We would profit greatly by knowing the potential skin hazards of a substance before it is put into use; we would be able to take proper precautions in the cheapest and most satisfactory manner and many undesirable incidences could be avoided.

In the literature there are many instances of irritation tests upon the skin of animals, but apparently there has not been a comprehensive study. In an attempt to develop an experimental method, we began about six years ago to study the responses of rabbits' skin to various types of substances. We considered the possibility that if enough were known of these responses to different types of compounds, particularly to those with which there has been considerable human experience, then these responses could be organized to form the basis of an experimental method.

Acneform dermatitis, characterized by such lesions as folliculitis, comedones, nodules, papules, pustules, and inflammatory changes, has been reported arising from exposure to quite varied substances including petroleum oils and greases, shale oil, paraffin, zinc oxide, chlorine, tars, pitches, chlorinated diphenyls, chlorinated naphthalenes, and crude chlorinated phenols.[1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 26, 27, 28, 29, 30, 32, 33, 34, 35] The recent occurrence in this country of such an acneform eruption,[4, 9, 12, 16, 28] sometimes called "chloracne," has attracted particular interest, and

we included in our animal studies five types of substances known to cause the reaction. Today we wish to describe the unusual response of the rabbits' skin to these materials and to consider its possible significance.

Experimental Part

IN OUR experiments, materials have been applied to the inner surface of the ear of albino rabbits and to the shaven belly. The undiluted materials have been used as well as solutions of various concentrations in olive oil, paraffin oil U. S. P., propylene glycol, ethanol, and water. Liberal applications were made on the ear without any covering. The applications on the abdomen were made in a small cotton pad which was covered by a large bandage of filter cloth held in place by adhesive tape. Applications were made once a day, five days a week, for four weeks or until a marked reaction resulted.

The responses obtained following the application of some hundreds of test substances are easily arranged according to type.

Certain of the strongest irritants produce a rapid destruction of the tissue (necrosis), without the skin having an opportunity to show an active response. Irritants with milder and slower actions than this have some effect upon the tissues, as a result of which we see certain responses on the part of the tissue. Most irritants have resulted in responses in the rabbits' skin which tend to develop rapidly and to subside in a short time. This relatively rapid response, which we have termed a simple irritation or reaction, may include, depending upon the severity, any of the following: hyperemia, congestion, inflammation, exfoliation, edema, blistering, sloughing, exudation, crustation, necrosis, induration, hair loss. Microscopically one may see hyperemia, congestion, hemorrhage, edema, blistering, leucocytic infiltration, sloughing, and various degenerative changes.

One type of response has been observed, however, which requires a somewhat longer interval in which to become apparent, and which has a much more prolonged course. This latent reaction is a proliferative response which may possibly occur in any of the structures of the skin, but that about which we are particularly concerned now is epithelial hyperplasia, with its resultant thickening of the skin, follicle enlargement and sequellae.

Naturally responses vary to some extent, and we have observed various combinations of these reactions, depending upon the substances applied to the skin and the intensity of action.

For purposes of classification we have arbitarily divided the proliferative response into the following five groups according to intensity:

1. Least detectable.
2. Very slight.
3. Slight.
4. Moderate.
5. Severe.

While there are naturally no sharp breaks between these, and some overlapping occurs, division was rather easy and has been very useful.

Least detectable epithelial hyperplasia: This degree of response is manifest as an increased prominence of the hair follicles on the inside of the ear. The little dots that one sees on the inside of the ear simply become slightly larger. After exposures are ended this enlargement regresses in a short time, leaving the skin apparently normal. This degree of response is commonly seen as part of a mild simple irritation which is maintained by repeated exposures. Thus far we have been unable to attach a particular significance to this intensity of reaction.

Very slight epithelial hyperplasia: This reaction appears on the ear as a slight enlargement of the hair follicles, which protrude and become hard, causing the ear to feel rough. The thickness of the ear may be increased. A very slight scaly exfoliation may accompany this degree of response, but seldom is there any detectable hyperemia or hair loss. On the abdomen one seldom sees any gross evidence of hyperplasia.

Slight epithelial hyperplasia: In this reaction the ear increases in thickness to about twice normal and feels slightly stiffened and "leather-like." There is some hyperemia, scaly exfoliation, and hair loss. The hair follicles become slightly enlarged, raised and hard. On the abdomen there may be a slight thickening of the skin and an exfoliation, but enlargment of the follicles is not apparent.

Moderate epithelial hyperplasia: This reaction consists of a thickening of the ear to 3 to 4 times normal as a result of which it is quite stiff and leathery. The follicles on the ear become moderately enlarged, raised and hard, causing the surface of the ear to feel like the coarsest of sand paper. After a time the protruding hard masses can be easily expressed by the finger-nail or by bending the ear. At times the enlarged follicles are not apparent until after considerable exfoliation has occurred. A moderate hyperplasia is usually accompanied by a slight to moderate hyperemia. Exfoliation of a granular or scaly type is of moderate intensity and hair loss is nearly complete. After a number of weeks the ear is completely denuded of hair, slightly pitted, with a slight or moderate hyperemia and possibly some exfoliation. The abdominal skin may show a greater simple irritation than does the ear; hyperemia, edema, and even sloughing and exudation have occurred. Hyperemia is usually maintained during the course of thickening. The abdominal skin finally becomes hard and stiff, followed by a marked scaly and granular exfoliation, which persists for weeks.

Severe hyperplasia: This reaction is usually preceded by a marked simple irritation, including even necrosis; however, there may be only hyperemia and edema. As a severe hyperplasia progresses, a marked hyperemia is evident until obscured by the thickened epithelium. The thickness of the ear is increased to many times normal, ears at least 1 cm. thick having been formed. As

a result they become very stiff, hard, and heavy. Exfoliation at first has a granular consistency, later flaky, and persists for months. The enlarged hair follicles are buried under the thickened epithelium and become apparent only after considerable exfoliation has occurred. From them large masses of keratin may be expressed leaving pits that may reach 2 to 3mm. in width.

On the abdomen the hardened mass of epithelium cracks and lifts off in large pieces like portions of a cast. Often beneath these is a soft, cheesy, foul-smelling material, which soon dries and comes off revealing a markedly exfoliating skin beneath.

The exfoliation often has a granular consistency at first, which later becomes flaky. There is a complete hair loss.

This proliferation of the epithelium seems to progress only to a certain extent, even with repeated applications of the provoking agent. The slowness and persistence of this latent reaction is to be emphasized. The maximum of a severe hyperplasia usually has occurred in the neighborhood of two weeks, the largest amount of exfoliation around four weeks, and a scaly exfoliation and hyperemia have persisted for months.

Although we make exposures upon both ear and belly, the skin of the ear appears to respond in the most satisfactory manner. There the mildest reactions are more apparent and the enlarged follicles are more easily seen. As a rule the abdominal skin shows a more marked simple irritation.

Histology

MICROSCOPIC examinations were made using 10% formalin as fixative, paraffin for imbedding, and hematoxylin-eosin as stain.

The slightest hyperplastic response is shown by a very slight increase in thickness of the epithelium and the development of small projections (like papillae) of but a few cells in size. The early stages of more severe responses show increasing degrees of thickening of the surface and follicular epithelium. Numerous projections reach downward from the surface epithelium, nearly to the cartilage of the ear. The follicular epithelium spreads outward and downward, often completely engulfing hair follicle and sebaceous glands. Apparently there is also a hyperplasia in the corium. Accompanying this hyperplasia, one may see congestion, even occasional hemorrhages, edema, and leucocytic infiltration.

Later the rate of proliferation apparently lessens and those changes resulting in keratinization become more evident. As those changes leading to keratinization progress from the lowermost layers of the epithelium, which constitute a basal layer markedly displaced from the original, large masses of material are thrown off. Thus in one section of abdominal skin we see a thick layer of partly keratinized and degenerate tissue being thrown off above a flat, normal-appearing stratum corneum. At the hair follicles most of the tissue undergoes complete keratinization, forming the hard plugs that may be expressed. Completely engulfed follicles and glands are destroyed as the hyperplastic epithelium is keratinized and thrown off.

The sebaceous glands have seemed to be inactive. One sees them, apparently normal, being engulfed by proliferating epithelium. Some glands, of normal size and appearance, are seen opening into the pits or cysts; others are seen with their ducts extending through large masses of keratinized epithelium.

Sections taken at a late stage show an atrophic or very slightly thickened surface epithelium and numerous large pits surrounded by slightly hyperplastic epithelium. The corium may still be thicker than normal.

Ultimately there is a tendency for the pits to broaden out and become shallower, and one sees a very irregular atrophic epithelium.

Discussion

THERE are certain points which indicate a relationship between this reaction observed in the rabbit and the acneform dermatitis of man. First, the reaction in the rabbit was produced by 5 types of substances known to cause an acneform dermatitis in man. They were chlorinated diphenyls, chlorinated naphthalenes, chlorinated diphenyloxides, crude chlorinated phenols, and petroleum oils. A few other types of substances have produced the epithelial hyperplasia, but there has been no exposure of these on man. Wacker and Schmincke[21] reported the experimental production of epithelial hyperplasia with various oils, fats, and paraffin. Sachs,[25] and others, apparently, have produced the identical epithelial hyperplasia in rabbits with a number of dyes. In his review of the pertinent literature, Sachs states that the most common dermatosis arising from exposure to aniline and coal tar dyes is eczema; however, warty growths and acneform dermatitis have also occurred. Thus it appears probable that the development of an outstanding hyperplastic response of the rabbits' skin is specific for those substances capable of causing an acneform dermatitis in man, and possibly, the related papular and warty eruptions.

Secondly, by gross and microscopic examination, the enlarged follicles produced in the rabbit resemble the comedones, nodules, and cysts of the dermatitis in man. In both cases there is a relatively large pit or cyst whose walls are composed of epithelium and which contains varying amounts of keratinized epithelium, and at times hair, hair follicles, and debris.

In both the rabbit and in man there is hyperplasia of the epithelium. Proliferative changes have not been stressed in descriptions of the human reaction and probably have not been seen to a greater extent because tissues were taken at relatively late stages of the reaction. There are reports of increased numbers of mitoses and of thickening of the rete Malpighii.[3, 24, 30, 34, 35] Prosser White[34] describes acanthosis in the "primary papule" and considers one important factor in the

production of oil folliculitis to be the chemical irritant causing auxetic cell growth. The ability of tar to cause active mitosis is well known. [11] Bornemann's[3] first case, examined at a late stage, showed more mitoses than normal and slight thickening; but in his second case, examined at an earlier stage, the thickening of the epithelium was much more marked.

Although mention is often made of sebaceous cysts in descriptions of the acneform dermatitis, only two instances were found of the specific mention of sebaceous glands in descriptions of the microscopic picture. Jones and Alden[12] reported slight edematous changes in a few glands they saw; Curgil and Acton[6] said that the sebaceous glands were unaffected. Bornemann[3] felt that the cysts were of sebaceous origin but admitted the difficulty of proof, and his description shows them to be essentially epithelial structures.

These facts, together with our experimental results, indicate that the so-called "sebaceous cysts" of the acneform dermatitis in man are directly the result of an epithelial hyperplasia. Their content of sebaceous-like material is probably due to the occurrence of inflammatory and degenerative changes in the mass of epithelial tissue. Of course, the retention of sebum may also occur, and influence the picture to some extent, but this appears to be a secondary reaction. Bacterial infection may be a factor influencing the nature of the reaction.

Conclusions

THERE have been a number of hypotheses concerning the formation of this acneform eruption in man. [34, 35] We feel that evidence shows this acneform dermatitis to be the visible response of the skin to an irritant acting upon it from the exterior, and that this response takes the form of first epithelial hyperplasia, second inflammatory and degenerative changes, and finally regenerative processes.

And in conclusion, it is possible that this apparently unusual response of the rabbits' skin offers us an experimental method which will indicate the ability of substances to produce an acneform dermatitis in man.

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Glycerol

—*Effects upon Rabbits and Rats*—

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BECAUSE of the wide use of glycerol as a solvent for compounds administered experimentally or therapeutically to animals and men, and in view of the discrepancies in the published reports on the toxicity of glycerol [1 to 9] certain observations have been made and are recorded in the following paragraphs.

The Toxicity of Glycerol

GLYCEROL (Merck's reagent) was administered subcutaneously, intraperitoneally, orally, cutaneously, and by intracardiac injection, to albino rabbits and rats.

Repeated applications of glycerol and of 50% aqueous solution of glycerol upon the abdominal skin of rabbits, in individual doses equivalent to 4.5 cc. glycerol per kilogram of body weight, did not result fatally in any instance. The animals were kept under restraint for two hours after each application. The undiluted glycerol, applied daily for 12 days, excepting Sunday, caused no reduction in the rate of weight increase, and no blood changes or other evidences of intoxication. The aqueous glycerol solution, applied daily for 25 days, exceptnig Sunday, was similarly without obvious toxic effects, except that the animals remained stationary in weight during this period, resuming normal growth at its conclusion.

TABLE 1
Summary of Lethal Effects of Glycerol on White Rats

Number of Rats	Dose cc/kg	% Dead	Time Till Death
Oral Administration			
5	13	0	
5	15	0	
5	17	20	3 hr.
5	19	20	10 hr.
5	21	40	2 hr.
5	23	60	2–10 hr.
Subcutaneous Administration			
5	7	20	3 days
5	9	0	
10	11	20	3 hr., 4 days
10	13	30	1 to 3 days
10	15	60	3 hr. to 3 days
10	16	70	10 hr. to 4 days
10	17	90	1 to 9 hr.
Subcutaneous Administration to Rats Starved for 3 Days			
5	13	80	1 to 3 hr.
5	15	80	3 to 4 hr.
5	16	100	2 to 3 hr.
5	17	80	1 to 3 hr.
Intraperitoneal Administration			
5	1		
10	3	10	3 days
10	4	20	25 min. to 2 days
10	5	40	50 min. to 3 days
10	6	80	30 to 100 min.
5	7	100	20 to 50 min.
5	9	100	30 to 60 min.
5	13	100	15 to 30 min.

Regardless of the mode of administration, lethal doses of glycerol produced restlessness, mild cyanosis, diminished arterial blood pressure, increased rate and magnitude of respiration, followed by decreased respiration, debility, diuresis, tremor, collapse, clonic convulsions, coma, and death in respiratory and circulatory failure.

Sublethal doses produced similar but less severe effects except that the debility, diuresis, loss of appetite and the consequent loss of weight were more pronounced. Several rats remained inactive for four days, but both rabbits and rats recovered after having suffered moderately severe convulsions. Rats showed no changes in alimentary activity, while rabbits, particularly those treated orally, occasionally showed a mild diarrhea.

Tables 1 and 2 summarize the facts with respect to the lethal and sublethal concentrations of glycerol.

Effect of Glycerol on the Blood Picture of Rabbits

A SINGLE lethal subcutaneous injection in the dorsal region caused a pronounced and prompt (in three hours) drop in the number of erythrocytes (from 5.6 to 1.6 millions per cu. mm.) and leucocytes (from 9.2 to 4.1 thousands per cu. mm.) and in the concentration of hemoglobin (from 11 to 7 gm. per 100 cc. blood). Weekly blood examinations on a group of five rabbits, each of which was given 16 subcutaneous injections of 2 to 6 cc. of glycerol per kilogram of weight over a period of seven weeks, revealed wide fluctuations in the leucocytes, diminution of erythrocytes from an average of six millions to four millions per cu. mm., and reduction in hemoglobin concentration from 13 gm. to 8 gm. per 100 cc. of blood, with prompt recovery upon discontinuance of the injections.

TABLE 2
Summary of Effects of Glycerol on Albino Rabbits

Number of Rabbits Employed	Dose cc/kg	Fate
Single Oral Administration		
4	6 to 12	inactivity, tremor, recovered
3	14 to 18	convulsions, death in 100 to 120 min.
Single Subcutaneous Administration		
6	4 to 8	slight diarrhea, recovered
5	10 to 18	inactivity, tremor, death in from 2 hours to 3 days
Single Intraperitoneal Administration		
4	4 to 6.5	inactivity, convulsions, recovered
3	7 to 9	convulsions, death in 60 to 110 min.

Each of five rabbits was given two injections either of 2 or 2.6 cc. per kg. of glycerol into the heart, at intervals of 24 hours. Each injection was followed by a decrease in erythrocytes (from six to four millions per cu. mm.) and the hemoglobin concentration (from 13 to 10 gm. per 100 cc. blood), and by a slight increase in leucocytes.

Sublethal intraperitoneal injections, given to six rabbits, induced no significant changes in the num-

ber of erythrocytes or in the hemoglobin concentration during the first four to six hours after the injection, but the leucocyte counts were increased by seven to 25 thousands per cu. mm. of blood. There was a reduction in the hemoglobin concentration at the end of 24 hours, the concentration had dropped from an average of 12 to 9.5 gm. per 100 cc. of blood.

The oral administration of lethal and repeated sublethal doses of glycerol produced no reduction in erythrocytes, leucocytes, or hemoglobin, in excess of the observed variations in control animals.

The Production of Hemoglobinuria

HEMOGLOBINURIA, observed in both rabbits and rats after subcutaneous injections of glycerol, was also seen in a few rabbits after intravenous and intraperitoneal injection, but never after oral or cutaneous administrations.

Gross pathology

THE gross pathological changes observed in the tissues of these animals agree with those reported by Plosz[10], Simon[6], and Kobert[2].

Summary

THE lowest lethal concentrations of glycerol for albino rabbits were approximately 7 cc. per kg. when given intraperitoneally, 10 cc. per kg. subcutaneously, and 14 cc. per kg. orally.

Doses of 5 to 6 cc. per kg., given intraperitoneally, killed from 40 to 80% of the rats; 15 or 16 cc. per kg. given subcutaneously killed from 60 to 70%; and 21 to 23 cc. per kg. administered orally killed from 40 to 60% of these animals.

Repeated and extensive applications of glycerol, alone or in 50% aqueous solutions, upon the skin of rabbits and rats did not induce definite or fatal intoxication.

Lethal subcutaneous doses of glycerol caused great reduction in the number of erythrocytes and leucocytes and in the hemoglobin content of the blood of rabbits, while repeated sublethal doses produced corresponding but less severe effects upon the erythrocytes and hemoglobin, and a wide fluctuation in the numbers of leucocytes. Glycerol injecetd into the heart produced a decrease in the number of erythrocytes and in the hemoglobin content of the blood, together with a slight increase in the number of leucocytes. Intraperitoneal injections resulted in considerable increases in leucocytes, but no other significant changes in the formed elements of the blood.

Hemoglobinuria occurred regularly after subcutaneous injection, occasionally after intravenous and intraperitoneal injection, but never after cutaneous or oral administration.

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Light and Life

—Some Glimpses into the Future—

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LIGHT has always been associated with Life, but never so concretely nor so specifically as in these recent months when the exploding knowledge of radiant energy has intrigued scientist and layman alike. Light — both visible and invisible — or, more properly, the radiations of far vaster extent than those to which the human eye responds, can do much to affect living, to directly combat disease and to minimize "human breakage." This knowledge is recent, but vital. It presages some vastly important new views and actions.

It is very difficult to predict what is going to happen in the field of applied radiation because in the last few years we have moved upward along diverse paths at an astonishingly rapid pace. I say this because we have developed some things faster than they could be either explained or applied.

Relations between life and radiation—the phase of electrical science I wish to comment on—began probably when our ancestors first undertook to control fire and light. It was 300,000 years ago, more or less, that our forebears, having previously come down out of the trees, disposed of their tails, and walked erect as men — appreciated the radiation from flames. Homo sapiens differed from the animal only in that then or thereabouts he found he could control fire and light and nurture radiation.

Some 30,000 years ago, our forefather back in those "dark" ages of pre-Folsom culture did have artificial lights, but he used them chiefly when recording his thoughts on the walls of the prehistoric caves. In this strange cycle of development, about 3,000 years ago or so, we find in man's records many references to the use of the pottery lamps or portable incandescent radiating devices as a means of safety in locomotion, but no physiological knowledge of other great uses of light beyond vision.

About 300 years ago, we still had as our only common source of artificial radiation the tallow candle. The day of non-visible radiation had not yet dawned. I emphasize these time figures because for so long we have known so little about the life-giving and pleasure-giving radiations that we cannot see.

Some 30 years ago, the advent of a drawn metal-

Address presented before the First Annual Meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, New York, June, 1940.

lic wire helix for a lamp filament suggested that we could develop economically almost all of the visible light we needed. For discernment; for safe locomotion; for means of decoration, plant growth or photography; for any other purposes to which radiation could be applied, some thought we had attained the maximum of light production.

But, if all the light sources we have had in any one year — if all the existing electric lamp bulbs could be grouped together as a great canopy overhead and all lighted at once—all the light sources of the American Continent — we still, with all of man's achievements, could reproduce the Creator's sunshine only over about one square mile of the earth's surface! So, we haven't done so

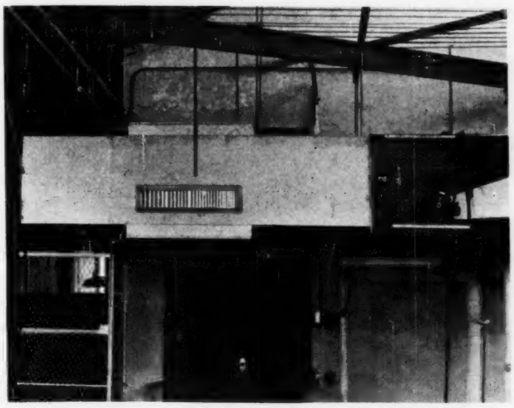

Fig. 1.
Sterilamps used in air-conditioning duct, Bloomfield Auditorium

well, quantitatively. But qualitatively we are doing better.

About five years ago, we developed or perfected some radically new means of converting electric energy directly into radiant (not necessarily visible) energy. And there begins our story, because the discovery of the transference of electrical energy to pulsating radiation of differing wave lengths has ushered in an era. We have begun the intriguing studies of new usages for radiation beyond that of mere vision. Studies of light for sight must continue; but studies of radiation for general human (and plant) welfare seem equally important.

For the purpose of refreshing our minds with the simple physics of this story (because the whole background of the future in the making and use of light depends on a knowledge of this fundamental), we may from one point of view regard all radiation as a species of wave motion, traveling as though along a taut rope being shaken by the hand. From whatever lamp or tube, or radiator, we may choose to use, we can say that as radiations go out in the wave form, then the length and only the length of the wave or pulsation establishes the basic character of the radiator, and generally the effect on the target or recipient.

If some particular radiation happens to have a wave length dimension of, perhaps, a meter and on up to several thousand yards, you know the kind of "light" that this would represent. We would *hear* it rather than *see* it, since these wave lengths constitute the radio broadcasting band. The "seeing eye" happens to be the radio receiving tube, in which the electron-sensitive coated plate is the "retina."

Suppose in another case that the wave-length is a small fraction of an inch long. That particular kind of broadcasting or "light" happens to be "seen" by the nerve-ends of the human skin instead of the nerves of the retina and we designate such energy as infra-red radiation or heat. If the wave length is a minute fraction of a millimeter, we call that "visible" light, simply because the human eye begins to record it—is tuned to that frequency.

When we undertake the measurement of those very short wave lengths, we cease to use the common linear dimension of a foot or a meter, rather measuring in Angstroms. The Angstrom unit is our linear measure for wave-lengths of light that the human eye can see. If this energy happens to have a wave length of about 8,000 Angstroms, we record it in the retinal receiving tube as "red light." If it happens to have about 4,000 Angstroms wave length, we know it as violet light; and all the other colors of the rainbow lie in between. The eye is a limited photocell, with a sensitivity range of about one octave. We might say

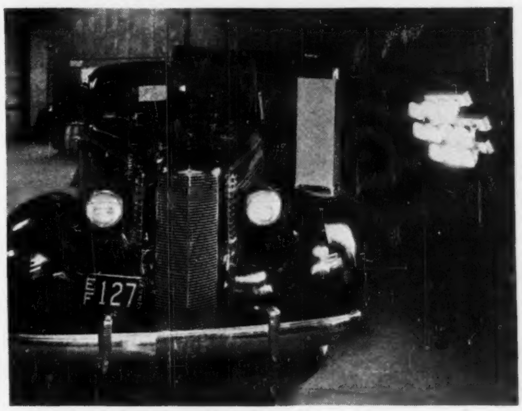

Fig. 2.
Infra-red or drying lamps being used on a quick paint or lacquer job

it is tuned to a broadcasting of a frequency somewhat in excess of 300 billion kilocycles per second.

But, for purposes of medical and health usage, we are interested in the wave lengths of light still shorter than 4,000 Angstroms. If they be between 4,000 Angstroms wave length, perhaps down to about 1800 Angstroms, we find numerous uses, generally but too loosely classified as ultra-violet applications.

If the wave length is only about 10 Angstroms or less, you know what kind of "light" that is too: we use it almost every day as commercial x-ray radiation. Still shorter wave lengths, the gamma rays from radium, are used, as you know, in cer-

tain tissue control. And the still shorter wave lengths, if these be waves at all, are the cosmic rays we read much about, but concerning which we must speculate as to whence they come or how they are produced.

All these radiations travel at the same speed. They all have related means of production electrically. We make and measure all of them except perhaps the cosmic rays. They are all, broadly speaking, kinds of light of different wave lengths. Like to the keyboard of the notes of the piano, we have the base tones which are analogous to

Fig. 3.
Author holding 4' fluorescent tubular lamp

the long wave or radio broadcasting radiation. At the right end of the scale are the treble or rapidly vibrating tones which we may liken to the cosmic rays and x-ray radiation; and in between, just one ivory key, which we can think of as middle C, represents the relative scope of light that you and I have known and lived by during all history. But melodies are not composed of one tone, and for the scientific symphonies of tomorrow we need a far broader gamut of vibrations than just the visible spectrum.

In the laboratory, the modern scientist recognizes that there may be as great a need for and as great a usage of the kinds of light to which the human eye is not tuned as there has been for the kind of light that we have heretofore carelessly called "visible." A charting of this gamut or the classification of a section of this wide-spread ether rainbow, will help direct our course of thought. Consider first the octave from 4000 to 8000 Angstroms. If our fundamental discussion is built around safety and seeing, as it is, for instance, in the case of street lighting, we most assuredly would consider a light source (such as the sodium lamp) having its maximum output at a wave length designated in Angstroms at about 5,500 to 6,000 because we would not usually see so well in the short waves or blues nor in the long waves or reds.

On the other hand, if our interest is in photography, or light's influence on silver salts, obviously the kind of radiation we need for that purpose (from the photoflood lamp) might well center at wave length 4200 A, since the panchromatic film sensitivity is high in these violet regions, low in the yellows and reds.

Beyond the limits of human eye sensitivity, in the long wave region, we find that the penetration of human tissue or of the cheek, which is the most convenient area of living tissue with which we can work, happens to be maximum at about 10,000 to 12,000 Angstroms wave length. Thus if our interest is in dilating the capillary blood vessels, or doing something in the way of applications of radiant heat energy to the curing of aches and pains

Fig. 4.
Holding a magic globe of glowing color

in minor diseases, we certainly would want to choose the source that has this wave length, and this penetration.

Happily, an infra-red lamp is available with such an output.

At the other end of the scale, note just three of the kinds of ultra-violet radiation with which we are concerned. First, near but beyond the limits of the human eye sensitivity at 3600 A wave length, we have the sort of "black light" useful for fluorescent paint excitation. In these days of wars and threats of war that kind of "light" is being used during black-outs in London; and, cer-

tainly, with the prevalence of air raids, it will be the most important kind of light some folks will have.

Of a still shorter wave length, we have the kind of radiation that produces erythema or develops pigmentation in the human skin. This is a very narrow wave band, at 3,000 Angstrom wave length, and a secondary peak of effectiveness around 2,500 Å.

Third in the ultra-violet classification is the tamed energy characterized as sterilizing or germicidal, having its peak of effectiveness near 2,500 Angstroms and a secondary peak (or an ozone productiveness) somewhere beyond the 2,000 Angstrom wave lengths.

How do we produce these radiations? As to developing the kind of light we would use for seeing

Fig. 5.
Sterilamps in counter cabinet irradiating drinking glasses

and for all of the safety operations that go with clear vision, we have had for 30 or 40 years incandescent filament sources. Could you imagine how many we have now for our usual needs? Not merely half a dozen; not a dozen; not a hundred—more than 6,000!

But all of these different varieties are rather incidental to our particular discussion at the moment. What we want to know is how can we produce light differently and apply it to unusual human needs.

One of the trends in extending human life or human comfort involves colored light, especially its more efficient generation. The eye is very sensitive to the yellow from ionized or excited sodium vapor, and so we produce sodium lamps for the lighting of our highways and the places where automobile traffic is dense—where we forego any thought of the complexion; we merely want to see objects. Pure visibility, then, is one question; and this is one solution.

We might also note that in addition to making light from sodium vapor, we can make a fairly good lamp using cadmium vapor, which happens to produce erythema very excellently, or which gives us the standard of physical lineal measure because of the basic wave length of its red line (6438-4696 Angstroms) or which paints every object pink, blue or gray and hence distorts our familiar world to such an extent that we may become nauseated.

The ionization or excitation of a vapor or gas will give us many different kinds and colors of light but thus far we have applied mercury vapor and neon to the advertising tubing; high pressure mercury to visible light production and low pressure to the generation of ultra-violet; tellurium vapor for a continuous spectrum source, etc. The by-products of such developments include the glowing flowers and figures in small bulbs for ornaments; self-luminous cocktail glasses; quick flashing lamps for the transmission of photographs by wire or for the talking movies; and sun-tan lamps for humans or animals kept in confinement. What at first was apparently a by-product but which now develops as the most useful tool of all, is the exactly controlled low pressure mercury tube generating bactericidal radiation. This, the Sterilamp, is the electrical "Fountain of Youth," for it is capable of protecting and lengthening human life.

When we want to kill bacteria or micro-organisms, we must have a radiation of a very carefully controlled wave length, and we must be sure that we know what kind of radiation we are getting. And we must know a great deal more than perhaps we do today about all of the applications.

But we do know this much today: that such a lamp producing an output chiefly in the wave length of 2,537 Å actually does kill micro-organisms, the spore of fungi, etc., by direct irradiation, and indirectly through certain changes in the atmospheric gases. Part of the most recent knowledge on that subject is an establishment of what we call the reciprocity law. This merely means that if you set out to kill small organisms, you may use a large amount of energy for a short time; or a little energy for a long time, but the product of the energy and the time tends to be a constant, when related to cell destruction.

Fairly husky organisms, like the paramecia, the ditch water single-celled animalcule, may be utterly destroyed in the millionth of a second by using a strong lightning flash of this particular Sterilamp radiation, contrasted with exposures to a relatively weak lamp of this nature for a matter of five minutes or longer before getting results. Long exposures have their uses, such as in a cabinet in which we would place gas masks, gloves, goggles, drinking glasses — anything around industrial plants that might go from hand to hand, face to face, or mouth to mouth. This includes flat silver or drinking cups in cafeterias,

irradiated for a few moments after washing. Around the rims of many drinking glasses, one may find a pretty formidable miniature menagerie, and every fleck of dust carries its parachute troops of enemy germs.

To prolong life this Sterilamp seems one of the nicest tools that has evolved since we began to use electricity for human betterment. We may kill the organisms in air-conditioning duct systems. We certainly will wish to irradiate our eating utensils. This harnessed death ray is applied to bottle capping and corking; in the packing of canned goods; in avoiding the growth of mold on cold cream and cosmetics; in meat and in bread prevervation — for inhibiting the spread of contagion. In the latest period of preparedness in industrial hygiene, then, the Sterilamp and its short wave radiations are inevitably being drafted for the duration of the bacterial war!

Not only does this kind of radiation kill bacteria, but it kills the spore of some fungi. We know what that might mean—anything from inhibiting vegetable plant diseases to "athlete's foot."

We know that another form of short wave ultraviolet radiation has its direct effect on human tissue. A low wattage quartz mercury lamp, governed by the dimensions of glass and its transmission qualities and by internal vapor pressure that permits any range of radiation from the limit of air transmission, perhaps 1,600 Angstroms or a little longer, up to the edge of the visible spectrum, is a device that, under careful medical supervision serves for sterilization of surface wounds; for the treatment of superficial or dermatological ills, or discouraging infection that can be reached by surface treatment. Surely the infections from the air are foremost among the things we must now govern in the great advance of antiseptic planning or aseptic surgery, or for protecting just plain massed human gatherings.

If we choose a different transmission of glass, and a different vapor pressure, we have such a lamp as we bring into the field of sun-tanning or skin marking. We can develop a visible skin pigmentation in a few moments that will persist several weeks. We stencil his initials on the back of the newly born child and there is no question about his being confused wtih another baby. Perhaps, if this is the time to discuss it, we should have no unknown soldiers in the next war because we may stencil identification numbers on the body that only a month or more of fading and nothing else will remove.

From similar lamps there comes another kind of radiation, which is vastly important. It is invisible, just as these killing radiations are invisible. It is popularly termed "black light," and it has a great bearing on military defense and on accidents.

"Black light" is being applied in so many ways that it is almost impossible to know where to begin its discussion. However, starting with something that is of portent in the field of human safety, consider some of the phosphorescent materials that are sensitive to this "black light" and which are light-storage batteries because they continue to glow in the dark for quite a while. Many colors of these materials could be applied to the wall paintings and paperings of the rooms of tomorrow.

Fluorescent materials delineate the handrails and stair treads of the modern factory. If there should be a blackout, either under impress of an air raid or from merely an ordinary accident, we would still have light sources that persist from five to 50 minutes with which one can be guided safely. Or, we may turn out the bedroom lights, undress, and retire at leisure under the slowly fading glow from the walls.

Invisible fluorescent patterns are common enough, too. We use them in concealed laundry marks, or double-message signs, or stage costumes. But as a safety measure, one best example is the fluorescent carpet to direct the footsteps in a darkened theater.

In the field of decoration and for the pure fun of living, we have fluorescent plastics. We also have in the field of printing some interesting things, such as the newly evolved usage of "black light" on fluorescent inks in lithography, causing the printed materials such as theater programs to shine very brightly in the dark. This might suggest an exit or danger sign, always legible—an example of what is practiced in England now in the marking of doorways. Fluorescent materials mark the streets and obstructions that shine as though under their own power.

The infra-red or heat rays influence our lives and our well-being also. In radiation's kit of tools we find therapy lamps; drying lamps; lamps to produce steam or to vaporize oils and perfumes, and more to come.

To illustrate one more tremendously important development which is going to affect all our lives, let us note the bright colors of minerals or ores such as willemite, when excited by exposure to short wave ultra-violet. These fluorescent materials, finely ground and coated on the insides of tubular lamps permit the transformation of invisible ultra-violet (2537A) to longer wave visible colors, at remarkable efficiencies. So, in addition to the enjoyment of all the rainbow colors reproduced at will, or in addition to the true daylight qualities of light for industrial processes, we may now look forward confidently to the time when indoor accidents due to darkness will be inexcusable.

In this world of tomorrow, in addition to the use of various colors of light, thanks to electric excitation of gases, or to phosphorus coating on the insides of great masses of glass simulating irridescent bubbles, we need feel no longer the limitations of a minute star imprisoned in a glass bulb since we possess great softly glowing globes or surfaces that re-radiate both visible and invisible energies. Then when we think of the lamps being born to purify air or water; to kill bacteria; to mark the skin; to reduce infectious diseases; to penetrate the tissue; and to do all sorts of jobs in addition to that one of enabling us to see — then

may we realize how broad are the services that light can render to life.

What will the future hold for us and humanity? Do some of these luminous globes, these captured bits of the aurora borealis, suggest that miracles of light are happening? Or that magic is in the air? Let me caution you, because the things that today seem magical are merely a little of the unknown—bits of tomorrow that we are glimpsing today. What seems magical today becomes the commonplace of tomorrow.

From behind the ordinarily closed curtains of the research laboratory, let us hearken to a message of promise and hope, because we all may see so many uses of radiation, of different wave lengths, of different colors and qualities, and types of uses that we must thrill to the surety of how life will enlarge, as light expands. Seemingly we have just begun to use new weapons to free humanity from the shackles of darkness; to give us radiation for enjoyment; for safety; for protection; for purification; for sterilization; for all sorts and purposes of which we never dreamed brief years ago.

These things we see as in a magic crystal. Knowledge of these new sciences of radiant energy seem as a torch of progress in our hands. We can join in being proud of it and in carrying it high!

Ventilation Problems

—in Industrial Hygiene—

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ENGINEERING, which was originally the art of managing engines, is now defined as the art and science by which the properties of matter and the sources of power in nature are made useful to man in structures, machines and manufactured products.

The first attempts in a new field are usually rather crude. The engineer concentrates on getting the new machine or process to actually work; afterwards efficiency is increased and costs are reduced. Later engineers realize that additional knowledge is required beyond the mechanical design of equipment. For example, when electric lighting was first introduced illumination engineering was unknown. There were too many unsolved problems in connection with the generation and distribution of electrical energy to give much thought to the amount or kind of illumination for various uses.

The American Society of Heating & Ventilating Engineers was organized in 1894, but 18 years later ventilation was still in ill repute. It was contemptuously referred to by physicians and others as "canned air."[1] A paper presented before the Society in 1912[1] on "Ventilation Problems" described the chaotic state of the art at that time and made the following comments:

> "Many are the supposed authorities and statements supporting our present ventilation standards, but actually little, almost no, basic or conclusive data are available which are acceptable to the biologist, physician or inquiring engineer."

Is that not possibly true today concerning some of our industrial poisons?

In the discussion of this paper the following comments appear on page 155 of the transactions.[2]

> "The reason why our knowledge of ventilation is in such a chaotic state today must be that long ago many statements which were not true were made regarding the problems of ventilation and these statements were copied and repeated over and over, until they were accepted as facts."

Should we not examine some of the current statements on Industrial Hygiene to be sure that we do not make a similar error?

Seven years later the A.S.H. & V.E. organized its research laboratory in the Bureau of Mines Building at Pittsburgh. The results of its first physiological research were presented in 1923 in the classic paper "Physiological Reactions to High Temperatures."[3] Since then progress has been rapid. Of the 23 A.S.H. & V.E. technical Sub-Committees now devoted to research eight are concerned with physiological problems, such as sensations of comfort, physiological reactions, treatment of disease, air pollution and purification, radiation and comfort, air conditioning in industry and sound control. Without such cooperative research, modern air conditioning would not be possible.

Industrial hygiene engineering is still a young profession. Should we not examine our status critically to be sure that all of our assumptions are based on factual data and are not mere opinions that have been quoted and requoted so often that they are accepted as fact?

The engineer desires standards for the design of his equipment and for measurement of its satisfactory operation. The American Standards Association has organized a committee to determine, establish and promulgate the allowable concentration limits of harmful gases, vapors, fumes, dusts and mists from the viewpoint of occupational disease prevention. It is to be hoped that when these standards are adopted they will be supported by factual data and thus not repeat the early historical errors of general ventilation.

Some of the proposed maximum safe concentration limits appear to have been based on opinion rather than on experimental data and without due regard for the experience with the use of the substances in industry. The publication of safe concentrations by one authority leads to the adoption by others, and too frequently, without questioning the validity of the limits. For insance, there is a growing tendency to assign to toluene a maximum safe concentration of 200 ppm. A thorough search of the literature has failed to disclose any factual data which supports such a low limit. However, experience shows that during the past 16 years, approximately 180,000,000 gallons of toluene have been used as a lacquer diluent, and the

speaker has been unable to locate any reported case of chronic toluene poisoning.

An English publication that has been frequently quoted on the toxicity of toluene gives the following conclusion:[4]

> "Toluene is a poison of the same type and action as benzene but acts less readily because of its physiochemical properties."

Yet on page 557 of the same article, the following statement is made:

> "It is scarcely possible to regard these inhalation experiments as illustrative of chronic poisoning, however, for the effect was acute, and the exposure had to be short in order to avoid death of the animal."

This confusion between chronic and acute poisoning has been noted in other publications. Chronic poisoning refers to the slow pathological effects for the prevention of which maximum safe concentrations have been proposed. "Acute," as used by physicians refers to "a rapid onset, a short course and pronounced symptoms and termination."[5] This definition well describes the asyhpxiation caused by extremely high concentrations of hydrocarbon vapors. Acute has been used by some engineers in the sense of meaning severe.[6] It is important that the engineer and physician speak the same language so that each one understands the other.

Without proper units of measurement the engineer is greatly handicapped. When units do not exist he invents them, as for example, decibels for the measurement of sound and lumens for the intensity of illumination. The definitions of these words are clear and concise, but what is the proper unit for toxicity? If one solvent or gas is said to be more toxic or more poisonous than another, what is the basis of comparison? To the physician it might mean the lethal dose. To the safety engineer it might mean the concentration in air that will produce asphyxiation or acute poisoning. To the industrial hygienist it would probably mean the ppm. that is safe for prolonged breathing. Under what conditions is it permissible for a manufacturer or salesman to claim that his solvent or chemical is non-poisonous? Industrial hygienists know that all volatile solvents with the possible exception of water are poisonous, and that the difference is one of degree only. The plant executive and sometimes the safety engineer does not realize this fact, and hence is very ready to accept unsupported statements that a given solvent is not poisonous.

The warning labels on industrial solvents adopted by the U. S. Public Health Service contain the statement "Use with adequate ventilation." What does this mean? To us who are specializing in industrial hygiene it means sufficient ventilation to reduce the vapor concentrations in the breathing zone of the workmen below the allowable safe concentration. To the factory man it might mean a fan blowing the vapor into the face of the operator.

Determination of the vapor concentration in workroom air will indicate if additional precautionary measures are required. This procedure, however, is not always practical, when minute amounts of a toxic substance are used. For example: If I use enough of a rubber cement containing benzol to paste two pieces of paper together in a large room, there is obviously no hazard since the resultant vapor concentration is far below 100 ppm. or even 50 ppm. Suppose, on the other hand, that each one of a large group of persons were using the cement eight hours daily in this same room without exhaust ventilation. In that case a health hazard might result.

How can we specify to the user who is not technically trained the approximate border line where exhaust ventilation becomes necessary? Probably the most easily understood description would be in terms of quantity of material used per volume of air in the workroom, such as ounces of rubber cement per 1000 cu. ft. of air.

APPROXIMATE BORDER LINE CONCENTRATIONS

	Mol. Wt.	Safe Conc. p.p.m.	Weight lb/gal. 25°C	Cu. ft. Vapor per gal. 25°C	Gal. per 1000 cu. ft. at safe conc.	Oz. of liquid per 1000 cu. ft. of air (25°C) at safe conc.
Amyl acetate	130	400	7.13	21.5	.0186	2.38
Benzene	78	100	7.28	36.6	.00273	.35
Butyl acetate	116	400	7.25	24.5	.0163	2.09
Carbon bisulfide	76	15	10.45	53.9	.000278	.03
Carbon tetrachloride	154	100	12.95	33.0	.00303	.39
Dichlorethyl-ether	143	15	10.11	27.7	.000542	.07
Ether	74	400	5.98	31.7	.0126	1.61
Ethylene dichloride	99	100	10.39	41.1	.00243	.31
Methanol	32	200	6.21	76.0	.00263	.34
Tetrachlorethylene	166	200	13.20	31.2	.00641	.82
Trichlorethylene	131	200	12.12	36.2	.00553	.71

The foregoing table illustrates a method of expressing this border line where exhaust ventilation becomes necessary. A few solvents are listed for which safer vapor concentrations have been proposed in various states. From the molecular weight and the weight of one gallon of liquid the cubic feet of pure vapor at 25°C. from one gallon of liquid have been calculated. The fraction of a gallon of liquid which will produce in 1000 cubic feet of air the proposed safe concentrations in parts per million has also been calculated. The ounces of each of these chemicals that will be evaporated into 1000 cu. ft. of air at 25°C. with-

out exceeding the given safe concentration values are expressed in the last column. One method of using these data is based on a minimum natural ventilation, say, 10 cu. ft. per minute per person, or approximately 5,000 cu. ft. of air per person per eight-hour day. On that basis, 1.8 ounces of benzol could be used per day per person. Another method is to assume the minimum daily air leakage into a room. If, for example, we have a 10 ft. ceiling and four air changes per day in a closed room without exhaust ventilation, then one pint of benzol could be evaporated for each 1000 sq. ft. of floor area without exceeding the maximum safe concentration. These methods of expressing safe concentrations are not recommended as the best, they are merely illustrations. The important factor is to express the quantity of toxic material that may be safely used in such terms as may be readily understood by the factory foreman or the safety inspector.

The present status of industrial hygiene ventilation is probably on a more sound basis than the field of general ventilation was 20 years ago, yet the marked improvements in the latter may give us an indication of the possibilities for improvement in our own field. No small part of the satisfactory operation of modern air conditioning equipment is due to mechanical improvements, such as reliable automatic controls. Automatic alarms and recording instruments are already in used in our field. The carbon monoxide alarm installed in the Holland Tunnel in 1926 is probably the first example. Automatic alarms are also in used for mercury, carbon disulphide and hydrogen sulphide. An example of automatic control without manual attendance is the short vehicular tunnel on Park Ave. south of Grand Central Station in New York City.[7] A carbon monoxide detector automatically starts additional fans when the CO concentration reeaches three parts per 10,000. At six parts it operates the traffic lights to divert traffic around the tunnel. The development of reliable automatic alarms and automatic control for other toxic vapors or gases and a later reduction in their cost will probably have a marked effect in increasing the safe use of toxic vapors and gases.

For smaller users where the expense of an automatic alarm is prohibitive there will probably be an increased use of indicating instruments of the direct reading type to replace the laborious chemical methods of air sampling and analysis now in use. At first these instruments may require technical training to take readings and to interpret the results. Later they will probably be simplified, easier to manipulate and lower in cost. One doesn't have to be an automobile engineer to read and interpret the instruments on the present-day automobile dashboard. If each factory where toxic solvents are used should have a direct reading instrument to measure the air concentrations of the toxic vapors and gases, a reduction in the health hazard would undoubtedly follow.

Psychrometric data and charts have been in use since 1908.[8] They express the properties of mixtures of gases and condensable vapors. For mixtures of air and water vapor these data and charts have been gradually perfected and are constantly being applied in air conditioning and drying processes in industry. It is only recently that similar relations have been determined for industrial solvents, such as acetone, carbon-tetrachloride and benzene.[9] The application of these charts to problems of solvent recovery and removal of toxic vapors will result in improved design of equipment.

Mechanical improvements in dust removal equipment are to be expected. For example, dust particles in rapid motion become electrically charged but the electrical properties of dusts in motion are little understood today. A patent has been issued for electrical precipitation of dusts by using only mechanical motion of dust and air to charge the dust particles.[10] Improvements in air filtration may result when the laws by which mechanical motion creates electrical charges are better understood.

If the history of other types of engineering is to be repeated we may expect a marked improvement in industrial hygiene ventilation during the next 20 years and a continued reduction in occupational disease cases. To attain this objective, cooperation of the medical and engineering professions and further research by both is essential.

In closing I wish to emphasize the following points:

1. Codes of maximum allowable concentrations are very desirable. They should be based on factual data.

2. Maximum allowable concentrations apply to the prevention of chronic poisoning and should not be confused with relative toxicity which apply only to acute poisoning.

3. It is desirable to express the amount of toxic solvents that may be safely used without exhaust ventilation in terms readily understood by factory foreman or safety inspectors.

4. Future development and increased use of automatic control equipment and automatic alarms for unsafe gas or vapor concentrations is indicated.

5. Further development and use of direct reading indicating instruments for toxic materials will materially reduce the hazards of industrial poisoning.

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News and Notes

THE year 1941 finds us with a growing membership which is becoming more and more active in the prosecution of industrial hygiene activities. The New England section has held its annual fall meeting at Portsmouth, New Hampshire, under the auspices of the New Hampshire Division of Industrial Hygiene. The following notes on this meeting were received from PROFESSOR PHILIP DRINKER who was instrumental in arranging for this interesting conference.

Those attending the conference included personnel of the Divisions of Industrial Hygiene of all of the New England States and New York, insurance companies, universities and industries. Trips were made through two manufacturing plants which demonstrated the processing of gypsum and the manufacture of paper buttons. Several scientific papers were presented and discussed during the evening and morning session. The papers presented were:

"Health Aspects of Arc Welding," B. D. TEBBENS, Harvard School of Public Health, Boston, Massachusetts.

"Field Testing of Industrial Ventilation Installations," W. C. L. HEMEON, Division of Occupational Hygiene, Massachusetts State Department of Labor and Industries.

"The Comparison of Quick Methods for Quantitating Impinger Samples of Granite Dust," MESSRS. POOL, WURAFTIC and KELLY, Division of Industrial Hygiene, Rhode Island State Department of Public Health.

"Methyl Cellosolve Poisoning," WILLIAM DAVIS, Liberty Mutual Insurance Company, Boston, Massachusetts.

"A Survey of Dental Laboratories in Connecticut," JOSEPH MASSARO, Division of Industrial Hygiene, Connecticut State Department of Health.

"Biological Studies of Carbon Disulfide in Animal Tissues and Fluids," RALPH W. MCKEE, M.D., Harvard School of Public Health, Boston, Massachusetts.

"The Administration of Industrial Hygiene in New Hampshire," FREDERICK J. VINTINNER, Diviison of Industrial Hygiene, New Hampshire State Board of Health.

NILS R. BERNZ, Secretary-Treasurer of the New York Section for 1939-40, reports that DR. WILLIAM G. NIEDERLAND on November 6 gave an interesting discussion on "Industrialization and Industrial Hygiene in the Philipines," with some 25 members present.

New officers elected for 1940-41 were: MR. F. A. PATTY, Chairman; DR. LEONARD GOLDWATER, Vice-Chairman; MR. WILLIAM J. BURKE, Secretary-Treasurer.

Also announced was the meeting held December 18 when COMMANDER C. S. STEPHENSON U. S. N. gave a timely and interesting discussion on "Industrial Hygiene and the National Defense."

WM. WITHERIDGE, the new Secretary-Treasurer of the Michigan Section, reports that the meetings of the American Public Health Association in October were deemed sufficient to take the place of our October meeting. However, DON CUMMINGS, President-Elect of the Association, gave a very interesting talk November 30 in Detroit on "Silica and Other Dusts." Approximately 40 persons gave an enthusiastic reception to this talk and the writer still is hearing pleasant echoes from this address. J. J. BLOOMFIELD will present the next talk before the Michigan Section which will be held at Ann Arbor, Michigan, in conjunction with the Seminar conducted by the University of Michigan School of Public Health. The Michigan Section also collaborated in the Saginaw Valley Conference on Industrial Medicine and Industrial Hygiene.

The Chicago Section held a meeting in October to discuss the engineering and physiological phases of benzol. MR. P. W. GUMAER, of the Research Department, the Barrett Company of New York, presented the former phase of the subject and DR. H. H. SCHRENK, of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, presented the latter aspect. The winter meeting of this section is to be held on January 30, 1941, at which Mr. B. F. POSTMAN, Industrial Hygiene Engineer of the Bureau of Occupational Diseases, Connecticut State Department of Health, will present his experiences in the engineering control of occupational disease hazards.

Of the other sections, that in Pittsburgh is active in making arrangements for the Annual Meeting to be held there in May. Dr. E. G. MEITER intimated during the Air Hygiene Foundation Meeting in Pittsburgh that we should be soon hearing from a Milwaukee Section. A number of persons in the St. Louis area have stated their interest in a projected local section for the Missouri and Kansas region and it is hoped that plans will materialize during the coming year.

—GORDON C. HARROLD, Secretary.

The Physician and the Official Industrial Hygiene Agencies

A SURVEY of activity in the field of industrial hygiene in the United States draws attention to the increase in the number of official consulting and investigative agencies in this field. State and federal governments as well as other agencies are expanding their programs. The range of medical activity in industrial health is so wide-spread and frequently of such special character as to require the services of physicians in many categories of public and private employment. Physicians in industry may be classified according to whether preventive or remedial services preponderate in their ordinary activities. At one extremity is the medically trained industrial hygienist, concerned mainly with the elimination of environmental and personal factors underlying lost time in industry. At the opposite end is the private physician in general or special practice, who is most frequently called by employers or insurance organizations to treat individual cases of compensable industrial disability. The industrial physician bridges the space between these two extremes of professional approach. He applies the principles of preventive medicine and surgery in relationship to specific working conditions and also treats accidents and diseases of occupational origin in keeping with the employer's legal responsibility. Physicians in each of these classifications have indispensable functions to perform for industry. The actual share of the total preventive medical activity which industry needs and which these varying types of physicians undertake will vary widely in keeping with local requirements. In the inevitable expansion of industrial medicine the work of physicians in all these groups must greatly increase.

Medical leadership has the responsibility for developing proper orientation in industrial health. From the evidence presented in the survey by the United States Public Health Service, opportunities for constructive services are great. Since the private practitioner treats all nonoccupational causes of lost time and a majority of occupational causes as well, reductions in industrial absenteeism rest largely in his hands. He should extend his acquaintance with industrial exposures and his competence to correct them. He should report injuries and diseases promptly to the official agencies responsible for their control and he should call on them for advice and consultation whenever local facilities for such services are incomplete or absent.

Public health administrators will find it advantageous to promote a sustained interest and watchfulness on the part of individual physicians who desire to serve more competently and extensively in this field. They should underwrite the programs which medical organizations are developing with this end in view. In the absence of enough trained personnel, existing facilities for investigation of industrial health exposure provided by individuals and by individual laboratories need to be fostered and supplemented.

If suitable relationships between public and private agencies are borne in mind, investigation and consultation in industry can be undertaken with the full understanding and active assistance of the interested professional groups. Too often, in the past, there has been failure to arrange cooperation. This failure must be recognized and surmounted if the best interests of the worker are to be paramount.

Editorial in *J.A.M.A.*, January 4, 1941.

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